CONVENTIONAL OIL AND GAS, TENURE ACQUISITION AND DRILLING

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Prepared by:

Tamarack Solutions Inc.

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BUILDING BLOCKS FOR ECONOMIC DEVELOPMENT & ANALYSIS

PREFACE

PURPOSE

Building Blocks have been conceived and developed by the Economic Development Branch of the Ministry of Sustainable Resource Management, under the guidance of Nancy South, Manager Economic Analysis, as an analytical tool that supports British Columbia coastal and land and resource use planning and decision-making and economic development initiatives. The Blocks contain concise business and sector information for a broad range of resource-based business types in BC. At this point, there are more than 30 Blocks either complete or in draft form. Several more Blocks have been identified as high priority by planning tables and other client groups. Additional Building Blocks will be developed over time, and some Blocks may be updated. For the most current Building Blocks, please see the Ministry of Sustainable Resource Management website, at: http://srmwww.gov.bc.ca/rmd/ecdev/

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BENEFITS

Building Blocks are expected to provide the following general benefits:

- Increase efficiency and more informed decision-making by providing readily accessible, credible information to planning and economic development processes;
- Improve the consistency of economic information across planning areas;
- Support economic analysis and decision-making that occurs outside formal coastal and land use planning processes; and
- Provide linkages between economic analysis and other social and environmental analytical tools (through identifying resource requirements to support economic activities and general compatibilities with other sectors and values).

LIMITATIONS

Every effort has been made to ensure that the information contained in Building Blocks is accurate and consistent. Approved, credible data sources are the foundation for Building Blocks. All Blocks were reviewed by sponsoring agencies and other experts. However, users are cautioned that information is used at their own risk, and that the authors and sponsors are not liable for any damages. Any conclusions or interpretations by the authors are not intended to represent government policy. Also, note that Building Blocks do not provide site specific information nor do they consider requirements for sustainability (social, community, environmental).

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RECOMMENDED REFERENCE/CITATION

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1.0 OVERVIEW

1.1 Description

British Columbia is the second largest natural gas producing province in Canada and accounts for 13% of Canada's production. Most petroleum activity takes place in the northeastern section of the province. Large, world-class natural gas discoveries have focused significant interest in this area. Industry expenditures in British Columbia reached $4.3 billion and a record number of wells (850) were drilled in 2001. Crude oil and condensate production, and natural gas production in 2001 were 2687 10^3m^3 and 29.9 10^9m^3, respectively. The sales value of this production was around $5.6 billion. Direct revenues from royalties and oil and gas rights were $1.7 billion.

1.2 Industry Components

The exploration and development of oil and gas is a capital-intensive process that from the onset is focused on producing hydrocarbons to a sales point in the shortest and most profitable manner. Following is a description of exploration and development elements and decision processes. Information related to the maturing and production of resource basins can be found in Section 10.

Wide Area Geological Review (conducted in corporate head offices, normally located in Calgary or foreign countries):

- Publicly available geological and geophysical data and information from data vendors are investigated. Seismic data can be purchased from data vendors in a raw or processed form.
- Geologists and geophysicists begin by researching data made available by governments.
- Government data includes subsurface electronic well logs, drilling reports and oil and gas production reports.

Acquiring Oil and Gas Rights - Proposals and Decisions (typically made in Calgary; some decisions include review by foreign offices):

- A company will usually participate in a tenure competition with other partners. Companies seek out partners to reduce their risk.
- Companies bid on the basis of their wide area geologic review. The level of bonus paid is dependent on the estimated quantity of gas or oil, the cost and timing to drill a well, the royalty and taxes payable to the Crown, the proximity to a pipeline and plant infrastructure, and the expected price that can be realized at the nearest sales point. This information is processed in economic models that assist in determining the level of bonus paid to the Crown.

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The following three activities all require surface land access, through agreements with the Crown or landowner, in the case of private land.

Geophysical Exploration (decisions on geophysical contracts and programs are usually made in Calgary):

- Geophysical technology greatly reduces the risk of drilling. Wells are drilled to test a geological theory or model that is generated in the Wide Area Geological Review and validated by seismic data. The relative position of rock layers can be imaged from the patterns of acoustic sound waves that are reflected from subsurface formations.
- For two-dimensional (2D) seismic operations, field crews run parallel lines of sound recorders at wide intervals to cover large areas in a relatively inexpensive manner.
- Once a field is discovered, 3D seismic can be run in a grid pattern with close sound recorders to delineate the most attractive places to drill additional wells and determine the areal extent of a formation.

Drilling (drilling contractor selection may be done in Calgary; supervision in Fort St. John):

- Initial activities are road, site and well location surveying, followed by road and lease clearing, grading and applying gravel.
- The drilling rig is moved on site and crews work 24 hours a day to drill a hole ranging in depth from about 1000 metres to 3000 metres.
- Once the hole has been drilled to the target formation, the well is logged with electronic downhole measurement tools to record the characteristics of the subsurface rock formations.
- If logging indicates the well is productive, it is cased with steel pipe and a wellhead of shutoff valves is installed to prepare for production. The well is completed by perforating holes in the casing at the depth of the producing formation.

Gathering and Processing Systems and Facilities (designing is typically done in Calgary; project management and decisions on contracts can be made at regional offices such as Fort St. John):

- Pipeline connections to gas wells are necessary linkages to gas processing plants and wide-area transmission lines. Oil wells are typically connected by pipelines to treating facilities. Oil can be trucked from remote or low productivity wells that do not economically support pipelines.
- Gas plants remove sour gas (hydrogen sulphide [H_2S]), carbon dioxide, nitrogen and water from raw gas.
- Oil facilities, typically called oil batteries, remove natural gas and water from the oil stream prior to transport via oil transmission lines.

Abandonment and Reclamation

After wells are shut in, well casings are sealed and cut off below surface to abandon the wells. Surface sites and pipeline rights-of-way are reclaimed. Pipelines are abandoned by displacing hydrocarbons, filling the pipe with inhibited water and cutting off surface risers. Eventually wellsites, cut lines and roads are returned to a state that can sustain native vegetation.

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The information presented above describes what is known as the "upstream sector" of the oil and gas industry. The midstream and downstream sectors, which are beyond the scope of the Conventional Oil and Gas building blocks, are described below.

Midstream Sector

This sector consists of pipeline systems that connect producing and consuming areas. Other midstream facilities extract sulphur and natural gas liquids (NGLs), store products, and transport products by truck, rail or tanker. Gas transported via major transmission pipelines is typically comprised of methane and ethane. (Propane, butane and other NGLs are removed and stored before entering a gas transmission line.)

Downstream Sector

This sector consists of refineries, gas distribution utilities, oil product wholesalers, service stations and petrochemical companies.

1.3 Tenure Acquisition and Drilling - Details

This building block addresses tenure acquisition and drilling. Building blocks that address geophysical exploration, and gathering and processing systems and facilities have also been developed. Production revenue has been captured in the latter building block.

With a few historic exceptions, subsurface energy rights are owned by the Province. The Ministry of Energy and Mines (MEM) issues exploration permits, drilling licences and production leases (which also provide exclusive drilling rights). Access constraints and specific conditions may be attached to disposition notices, following inter-agency referrals. Well authorizations must be obtained from the Oil and Gas Commission (the Commission) prior to drilling wells.

Industry Structure and Activity

- The majority of land surveyors and drilling contractors are in oil industry towns; Fort St. John is the predominant location in British Columbia.
- Certain brush clearing activities may be subcontracted to local forestry subcontractors.
- Surveying and lease construction are conducted; in most cases, road improvements or construction are required. Sensitive sites may be drilled using helicopters.
- Rig is supported by a rig manager (toolpush), driller and crew, a geologist and a drilling mud specialist.
- The drilling crew and supervisory staff are housed in a temporary camp.
- Drilling programs will vary depending on the formation sensitivity to drilling mud, H_2S concentration expected to be encountered, need for directional or horizontal drilling, and coring and testing requirements

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Primary Activities

- Lease, Access and Camp Preparation
  - surveying and clearing of access road and wellsite (existing roads used where possible)
  - constructing of temporary road and watercourse crossings
  - improving existing roads where required
  - preparing emergency response plan if required by the Commission
- Drilling
  - drilling of surface hole with rotating drill string and bit; circulating drilling mud to cool the drill bit and carry drill cuttings to surface; setting surface casing with cement to secure walls, control drilling mud and fluids encountered during drilling, and prevent contamination of groundwater
  - installing blowout prevention equipment to control well during drilling operations
  - pulling out (tripping) drill string to replace bit during drilling operations
  - logging well with electronic and other wireline tools to identify and analyze zones with production potential; conducting of drillstem tests
  - setting of intermediate casing if required; plugging of hole if well is a non-producer
- Completions
  - setting of production casing (if well has production potential)
  - removing drilling rig and replacing with truck-mounted service rig
  - installing production tubing and wellhead
  - perforating well with perforating gun (on wireline)
  - conducting well stimulation by acidizing and/or fracturing if required
  - installing artificial lift for non-flowing wells (e.g., rod string and pumpjack for oil well; bottomhole pump for gas well)
- Rig Dismantling and Site Completion
  - removing debris and other waste material from the drilling site and the right-of-way
  - remediating sump pits and waste
  - backfilling pits or pond areas
  - plugging well if abandoning (i.e., to ensure all usable water and porous zones are covered)
- Well and Road Abandonment
  - capping cased well (i.e., to ensure all usable water and porous zones are covered)
  - reclaiming and revegetating lease and road
  - deactivating permanent road (including stabilizing the road prism and clearing width, restoring or maintaining surface and subsurface drainage patterns, and revegetating)

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2.0 LAND RESOURCE REQUIREMENTS/SENSITIVITIES

2.1 Provincial Crown and Other Resources Required to Support Business

- Sub-surface tenure under the *Petroleum and Natural Gas (P&NG) Act*.
- Spacing for gas wells is normally one well per square mile (256 hectares [ha] or a "section" in the Peace River Block); an oil well is normally drilled in a 64 ha area.
- Surface rights (under the *Land Act* or from the landowner).

A typical well lease is 120 m X 120 m; in some cases (e.g., shallow wells), not all of this area is utilized. In sensitive or mountainous areas, the lease dimensions may be altered. The number of wells in a pool can range from several wells, as in the Foothills, to hundreds of wells, as in the Boundary Lake area (in the eastern border of the Plains-Fort St. John region).

- efficient, cost-effective access
- Provincial forest
- rangeland
- designated land use areas
- Agricultural Land Reserve
- aggregates for lease and road construction
- fresh water (for water-based drilling mud, waterflooding operations)*

* Water does not have to be potable for these purposes but must meet criteria to limit corrosion and be compatible with the formation. The volume required for drilling a well is about 100+m3. Waterflood volumes could be as high as 1.2 times the volume of oil ($10^6 m^3+$) produced from the pool. The injected water may come from a combination of sources, including producing formations, aquifers and surface sources.

2.2 Complementary/Conflicting Relationships with Other Resource Values

Although drilling and well operations may affect other resources, tenure planning and application review processes that take into consideration other resource values have been put in place to minimize or mitigate potential effects. Following are lists of issues that are addressed before drilling can proceed:

Complementary Relationships

- Lease roads can provide wildlife corridors and new access for recreation users and guide outfitters, trappers, residents, and communities.
- New access can increase the potential for forest, mineral and utility development and tourism.

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Possible Resource Conflicts

- Archaeological Sites – Improper access and wellsite selection can cause disturbance to archaeological sites and heritage resources, including heritage rivers.
- Ecosystems – The area may be impacted by alteration of drainage patterns, disturbance to native vegetation, surface disturbance and erosion, and the introduction of noxious weed species.
- First Nations – Activities may affect historical and current uses (e.g., spiritual, gathering and hunting sites) and/or areas used to exercise treaty or aboriginal rights. Companies and First Nations may enter discussions to identify ways to avoid or mitigate impacts.
- Fish – Alteration of drainage patterns and erosion can impact watercourses and destroy fish or fish habitat.
- Forestry – The clearing of access roads can result in a loss of timber resources, particularly if the timber quantity is uneconomic to recover.
- Water – Improper drilling, completion and workover operations may result in drilling fluid and product releases into (and contaminating) surface and groundwater.
- Wilderness – Wilderness values for areas, currently accessible only on foot or horseback, can be lost once new access and cut-lines have been introduced.
- Wildlife – The clearing of wellsites and access roads can alter and fragment habitat, and create access and linear sight-lines, increasing the potential for adverse impacts on wildlife populations, particularly during sensitive breeding, rearing or wintering periods.

Other Issues

- In addition to the potential resource conflicts listed above, drilling crews and well operators must take precautions to control flaring, properly dispose of drilling and camp wastes, and avoid releases of sour gas.

3.0 INVESTMENT REQUIREMENTS

The amount the industry spends on subsurface tenure bonuses and exploration and development drilling in British Columbia in a given year depends on a variety of factors, including commodity prices, the investment environment and corporate priorities. In the 10-year period from 1992 to 2001, spending on disposition bonuses fluctuated but has been rising since 1999. The number of wells drilled increased steadily, primarily because of increases in development drilling during the last few years. Bonus, fee and rental expenditures reached $490 million in 2001 (up from $290 million in 2000). Exploration and development drilling expenditures in 2000 were $360 million and $545 million, respectively.

3.1 Capital (Start-up) Costs

Tenure is awarded through a competitive bidding process. Because of this, the value of oil and gas rights in a given area can vary significantly from month to month. The 5-year average price for 1996-2000 was $269.90/ha. The average price reached over $500/ha in 2001. Prices tend to be higher in the Deep Basin or Foothills regions or in new fields, such as

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Ladyfern, where production rates are higher. The term of a drilling licence is normally three years, but in the Nechako (immature) Basin in central B.C., the term is four years.

The cost of drilling a well depends on the location, depth, mud-type and fluids expected to be encountered. If a well is expected to drill through sour gas zones, costs are increased because of emergency precautions that must be taken. In 2000, the average cost to drill a well was $1.17 million. The average well depth that year was 1560 m; in 2001, the average was 1790 m.

Road costs vary substantially from region to region and depend on features (e.g., stream crossings) specific to the selected routing. Costs can vary from $25,000/km in plains areas to over $60,000/km in plains and muskeg. In the Foothills region and immature basins, costs could increase to well over $100,000/km.

The following table shows the range of drilling statistics for cost areas within the different regions of northeast B.C. Exploration success has increased in most areas over the last few years because producers are taking less risk as they try to maintain deliverability. Opportunities to explore for large pools are passed up to avoid risk and operating in remote areas.

As illustrated in this table, the cost of drilling a well in the Foothills (i.e., South Foothills) is significantly higher than elsewhere because of the mountainous terrain and depth of producing horizons; however, the number of wells drilled per pool in the Foothills is significantly lower than the high numbers drilled in many Plains-Fort St. John pools. To drill three wells in a pool in the Foothills will cost around $20 million; to drill 40 wells in a Plains-Fort St. John pool will cost the same.

Region	Exploration Success (%)	Development Success (%)	Unrisked Exploration Well $1000	Unrisked Development Well $1000	Exploration Well Drilling Depth (m)	Development Well Drilling Depth (m)
Plains-FSJ	64 - 88	70 - 93	233 - 784	233 - 724	962 - 1963	897 - 1652
Deep Basin	74	78	1480	1367	2336	2222
Fort Nelson	65 - 81	94 - 95	777 - 844	865 – 968 (up to 1603 for horizontal wells)	1211 - 1629	1248 - 1713
Foothills	74 - 92	78 - 99	1798 - 6578	1782 - 6259	1713 - 2643	1706 - 2577

Wellsite equipment costs for gas wells are addressed in the building block for gathering and processing facilities and facilities. Oil well capital costs can include:

- Pump (downhole and surface equipment) - $70,000 (Plains-FSJ, Fort Nelson); $85,000 (Deep Basin)
- Battery (with treater) – $60,000 to $80,000/well (cost depends on number of wells tied-in; single-well batteries have the are the highest cost)
- Pipeline (3-inch, installed) – $40/dia.in.m ($/nominal diameter in inches/metre)

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3.2 Operating (Ongoing) Costs

Wellsite operating costs for gas wells vary with well depth, H_2S concentration of the gas and whether the well has a line heater or not. A line heater adds about $400/month. The following table shows the range of costs for the different regions of northeast B.C., based on the assumption that wells have line heaters, with the exception of the Foothills where wells typically have dehydrators.

Wellsite operating costs for oil wells depend on well depth and whether the well is flowing or requires a pump. These costs are also shown in the following table. (Horizontal well costs are not represented here, but will be somewhat higher than costs for conventional wells. Data was not readily available for these wells.)

Region	Sweet Gas ($/well/mth)	Sour Gas ($/well/mth)	Flowing Oil ($/well/mth)	Pumping Oil ($/well/mth)
Plains-FSJ	4800	7000	2700	4500
Deep Basin	5400	7700	3000	5000
Fort Nelson	4800	7000	2700	4500
Foothills (N)	4800	7000	N/A	N/A
Foothills (S)	N/A	20,000*	N/A	N/A

* Based on actual costs for wells with wellsite dehydrators.

3.3 Future Capital Costs

Well workovers to repair equipment, stimulate or recomplete a well are the major ongoing expense associated with well operations. These can range from $50,000 to $100,000 per well in most regions. In the Foothills region, a workover cost may range from $200,000 to $1 million, depending on the extent of work required.

4.0 INFRASTRUCTURE

4.1 Overview

The main infrastructure requirements for tenure acquisition and drilling are transportation, energy, telecommunications and support businesses. Companies must plan around spring break-up, to ensure rigs can be moved off before road bans are in effect.

Transportation

- BC and Alberta highways
- Secondary roads (logging, petroleum development)
- Temporary access, including winter roads
- Helicopter landing areas
- Commercial scheduled & chartered flights

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Energy (electricity/gas/propane)

- On-site diesel generation (if power is not available)
- Fuel for transportation, rig operations etc.

Telecommunication

- Land lines
- Cellular service
- Satellite phone; satellite-based GPS
- Satellite or radio-controlled SCADA (supervisory control and data acquisition)*
- VHF radio
- Computer

* These systems are for remote monitoring and controlling of well, pipeline and facilities operations.

Associated Businesses

- Repair and maintenance – vehicles and equipment
- Oilfield and industrial supplies and rentals
- Hauling, transport and hotshot services
- Trade and professional services
- Construction – access roads, lease
- Operator services
- Well services – wireline, workover etc.
- Laboratories – core and fluid testing
- Goods supply – camp provisions
- Safety, first aid, camp and catering services
- Accommodation in nearby centres (e.g., Fort St. John)

5.0 MARKET

British Columbia competes for oil and gas industry capital investments on a world-wide level. Head offices allocate funds, taking into account the regulations, royalty structure and taxes for a given jurisdiction. These and the risks associated with developing a play are weighed against parameters for equivalent opportunities elsewhere.

Subsurface tenure demand:

- Acquisition of tenure from the province is driven by geophysical interpretation and wide-area geological interpretation.
- Once permits are obtained, more specific geophysical exploration on specific reservoir prospects is conducted by an exploration company.

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- On December 31, 2001, there were 4.2 million hectares of active P&NG leases.
- The 2001 level of active leases is 31% greater than the 1991 level of 3.2 million hectares.

Drilling demand is driven by:

- likelihood of discovering reserves, based on geophysical exploration and delineation drilling;
- expectation of high near-term gas and oil prices; and
- likelihood a discovered reserve can be connected to pipelines and carried to market in an expeditious timeframe.

6.0 LABOUR FORCE

More than 32,000 people are working in the oil and gas industry in British Columbia. About 7,000 are actively engaged in exploration, production, development and related activities. The remaining 25,000 work in the downstream sector. Approximately 250 oil and gas service and production companies are working in the Northeast. Because Statistics Canada combines oil and gas labour figures with mining figures, it is difficult to break out numbers for oil and gas in most categories. In addition, some occupations are classified in general terms, based on their main activity (e.g., hauling gravel is under Transportation) and are not included under oil and gas statistics.

According to the Petroleum Communication Foundation, about 75 workers are directly employed in the drilling of one well, although only four to seven may be on duty at the rig. The number varies, depending on the type of well being drilled. The drilling crew consists of the occupations listed in the following table. Support workers are also involved, including site preparation workers, well service company employees, suppliers and drivers for hauling and rig moving.

The major occupations involved in conducting land surveys and drilling and operating wells include the following:

NOC Code	Occupation	Skill Level	Skills	Wages* ($/full year work)	Seasonality	Comments
2145	Petroleum Engineer (project, specialist, mgr.)	A	University degree	$70-100,000+	Year-round	Primarily based in Calgary
2154	Professional land surveyor	A	See above	Est. $40-70,000	Primarily winter**	
6242	Cook	B	Specialized training, work experience	Est. $30,000	Primarily winter**	

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NOC Code	Occupation	Skill Level	Skills	Wages* ($/full year work)	Seasonality	Comments
6642	Kitchen, food service helper	D	Work demo. or on-the-job training	Est. $20,000	Primarily winter**	
Major groups 72, 73	Trades, skilled transport and equipment operators	B	See above	Est. $40-60,000	Primarily winter**	
Major group 74	Intermediate occupations (transport, equipment operators etc.)	C	Up to 2 yrs. on-the-job training, specialized courses etc.	Est. $30-40,000	Primarily winter**	
Major group 8	Occupations unique to oil and gas industry (drilling crew, driller)	B,C,D	See above***	$17 to 31/hr plus subsistence, travel	Primarily winter**	

* Wages will vary widely depending on commodity prices, crew availability, location, work conditions etc. Therefore, with the exception of Code 2145 (based on the 2002 APEGGA salary survey), wages are estimated. The oil and gas industry typically pays higher than other industries because of winter, remote work conditions etc.

** May be year-round depending on where work is being conducted (i.e., in south or coastal areas).

*** Crew member(s) must also have safety, first-aid training.

7.0 CAPACITY

7.1 Subsurface tenure

- The total P&NG-rights inventory of 4.2 million hectares has a total of 3,724 producing oil and gas wells. On a gross basis, there is one well per 1130 hectares leased.
- Typically, gas wells in Canada are drilled at a density of one well per 256 hectares in developed gas pools. Oil wells are drilled at densities of one well per 64 hectares.
- "Ultra-mature" tight gas reservoirs in the USA have been drilled to one well per 12 hectares.

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7.2 Drilling

- Drilling rigs can be mobilized from British Columbia or Alberta.
- The 850 wells drilled in 2001 made an all time record for British Columbia. The number of wells drilled in 2001 is 73% greater than the ten year average of 492 wells. The increase in wells drilled was driven by high gas prices in late 2000 and 2001. Success at the Ladyfern field has renewed interest in the potential of British Columbia gas resources.

8.0 REGULATORY REGIME

8.1 Overview

This section summarizes the key local, provincial and federal regulatory requirements for acquiring tenure and drilling wells in British Columbia. In addition to regulating the issuance of P&NG rights and drilling activity, provincial regulations are designed to address issues related to archeological sites, First Nations, fish and wildlife, forests, and watercourses. The regulations also attempt to minimize adverse effects on other commercial activities such as forestry, agriculture, the recreational use of land and transportation. Following is a list of acts that address many of these issues:

- *Petroleum and Natural Gas Act*, R.S.B.C. 1996, c. 361
- *Forest Act*, R.S.B.C. 1996, c. 157
- *Forest Practices Code of British Columbia Act*, R.S.B.C. 1996, c. 159
- *Heritage Conservation Act*, R.S.B.C. 1996, c. 187
- *Land Act*, R.S.B.C. 1996, c. 245
- *Waste Management Act*, R.S.B.C. 1996, c. 482
- *Water Act*, R.S.B.C. 1996, c. 483
- *Wildlife Act*, R.S.B.C. 1996, c. 488

Note that subsurface rights are granted under the *Petroleum and Natural Gas Act*, while surface rights on Crown land are granted under the *Land Act*.

Drilling proposals require plans for public consultation (including Emergency Response Plan consultation) and notification, as outlined in Section II of the Commission's *Public Involvement Guideline*. Landowners, occupants and residents must be consulted, while local government authorities (whose boundaries are within specified distances of the well) must be notified of the program.

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8.2 Provincial

The Titles Branch of MEM is responsible for issuing subsurface P&NG rights owned by the Province in an equitable manner. These rights are granted in three forms of agreements:

- Permits (for exploration)
- Drilling licences
- Leases

The lead agency that administers drilling activity is the Commission. Its mandate is to provide a single-window to review industry applications, grant surface land rights and ensure environmental economic and social impacts are addressed. The Ministry of Water, Land and Air Protection (MWLAP) and Ministry of Forests (MOF) may become involved if there are compliance- and enforcement-related issues regarding environmental damage and/or stream crossings (i.e., in reference to the *Water Act* and Forest Practices Code.) MWLAP is the primary agency involved in the disposal of oil-based and other mud system wastes. If additional regulatory agencies should be involved in an application review, the Commission will notify the applicant.

Any company wanting to drill a well for the purpose of producing hydrocarbons must first obtain a *Well Authorization and Permission to Construct a Wellsite and Access* from the Commission. A checklist for a wellsite on Crown or private land or an agricultural lease must accompany the application to enable the Commission to monitor activities and ensure that the proposed wellsite and drilling program comply with First Nations, public and legislative requirements. Supporting materials typically include an Application for Changes In and About a Stream and a Timber Harvesting and Field Assessment Application. Merchantable species must be utilized as directed in the Master Licence to Cut document and may not be disposed of by burning.

8.3 Private Land

- The company must negotiate with the landholder an agreement defining the wellsite location and access arrangements. The landowner's consent must be submitted to the Commission, prior to a well authorization being issued.
- The clearing of land and salvaging of timber must adhere to the requirements of the landowner.

8.4 First Nations

- The Commission's Aboriginal Relations and Land Use Branch coordinates field activities with First Nations and determines whether there will be potential treaty right infringements. Consultation is conducted with the band(s) claiming traditional rights in the area.

Note: If the land is within an Indian reserve, it is under federal jurisdiction and the Commission would not be involved.

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8.5 Parks and Environmentally-Sensitive Areas

- Oil and gas drilling is not allowed in parks in British Columbia
- Directional drilling with no surface access is permitted on new tenures in specified protected areas. Surface access on existing tenures within protected areas will continue to be permitted.
- Resource development is allowed on all Crown land outside parks, including "special management zones." In the Muskwa-Kechika Management Area in the North Foothills, pre-tenure plans precede posting tenure and drilling, to ensure that oil and gas development will be sensitive to important environmental and recreational values.

8.6 Regional Districts and Municipalities

Land use impacts and zoning conflicts are normally the main concern for local governments. This is especially true of sour gas developments where setbacks may apply to other types of developments around sour gas wells and facilities.

8.7 Federal Government

In addition to the acts listed below, the federal government is responsible for administering other acts, such as the *Migratory Birds Convention Act*, that may affect some oil and gas activity applications.

Navigable Waters Protection Act

- This Act regulates any activity in, around, under and over navigable waters, and is administered by the Canadian Coast Guard (CCG) of the Department of Fisheries and Oceans (DFO). Authorization under the Act is required for all stream crossings on navigable waters.

Fisheries Act

- Fisheries and Oceans Canada is responsible under the federal *Fisheries Act* to protect fish and fish habitat in "waters frequented by fish." For example, the Act prohibits the harmful alteration, disruption or destruction of fish habitat unless authorized by the Minister.
- By federal/provincial agreement, MWLAP is responsible for the management and protection of freshwater fish and anadromous fish stocks of steelhead, cutthroat trout, and Dolly Varden char.

Canadian Environmental Act

- The *Canadian Environmental Assessment Act* requires that environmental assessments be conducted for federal projects, projects involving federal funding, projects on federal lands and projects requiring a specific authorization or approval under specified sections of other federal acts.

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8.8 Timing

- The Commission tracks the timing of all applications and monitors the status of approvals from other provincial and federal bodies that are participating in the decision on a subject application. The review period for applications can range from a few days, if the proposed project is straightforward and in a developed area, to years, if it is in a sensitive and immature area.

9.0 GOVERNMENT REVENUES

The oil and gas industry is a major contributor to the economy, at all levels of government. The total provincial revenue from Crown royalties and reserve dispositions reached a peak in 2001 at over $1.7 billion. (The amount for 2002 is expected to be lower because of lower commodity prices.) Tenure disposition bonuses, fees and rentals brought in $490 million of the $1.7 billion. In addition to these revenue streams, the industry produces many indirect sources of revenue through employment (and the collection of personal income tax) and the purchase of good and services within British Columbia.

Royalties on gas, gas by-products and oil are the major provincial revenue sources for the oil and gas industry. These payments are global in nature and not attributable to any one activity (e.g., geophysical exploration or drilling). Royalties are presented in the building block for gathering and processing systems and facilities; however, there are other revenue sources that are collected from the tenure acquisition or drilling stages. These are presented below.

9.1 Municipal

- Business Licence Fees
  - Variable – depends on community; typically $100/year
- Room Tax
  - Some municipalities charge an additional accommodation tax of 2%.

9.2 Provincial

- Application Fees
  - $500 (plus $3.50/ha/yr) – drilling licence
  - $100-500 (plus $7.50/ha/yr) - lease
  - $8400 – Application for a Well Authorization; $200 - examination and submission of wellsite plans; $300 - well name change or transfer
  - In addition to fees under these fees, other fees for Water Act and Land Act applications are collected; these range from $50 to $250.
- Corporate Income Taxes
  - 13.5% of taxable corporate income.

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- Employee Income Taxes
  - Based on the average wage level in BC for full time employment ($32,000), a total of 22% is collected in federal and provincial personal income taxes. The Provincial tax component is typically 1/3 of this total.
- Petroleum and Natural Gas Rights
  - In 2001, $375 million was collected from drilling licence dispositions. Fees and rentals contributed an additional $12.5 million. (Note: Tenure bonus amounts vary from competition to competition.)
- Property Tax
  - Based on assessed land value (e.g., $40,000) and buildings. Building values below a specified threshold (e.g., $10,000) may be exempt. ("Buildings" may include structures, tanks, pipe, foundations etc.) The annual property taxes on a typical well are in the order of $600 to 700. This payment typically covers the provincial school tax, provincial rural tax and local service taxes. Local service taxes are paid to authorities (e.g., BC Assessment, Peace River infrastructure).
- Social Service Tax
  - Qualifying machinery and equipment used exclusively in the exploration, discovery or development of P&NG deposits are exempt.

In addition to the revenue sources listed above, other provincial taxes, such as the accommodation tax of 8% (e.g., applied when industry employees stay in Fort St. John) and the provincial sales tax of 7.5% (on non-exempt goods), are collected as a result of oil and gas activity being conducted in British Columbia.

9.3 Federal

- Employee Income Taxes; Federal personal income tax is typically 2/3 of the total personal income tax collected.
- 26.12 % of taxable corporate income (i.e., for the average wage level).
- The federal sales tax is 7.0% and is charged on all goods and services.

10.0 INPUT-OUTPUT TABLE

The following table, based on 2001 data, summarizes the costs and revenue streams associated with producing gas in B.C. (Oil production is not illustrated here since gas production far exceeds oil production in the Province). Cost, revenue and production streams were discounted at 10% to determine unit costs (i.e., $/mcf). Provincial burdens and federal tax were relatively high because of high commodity prices.

Input costs in all categories have been increasing in the last five years, while pool sizes and average deliverability rates have been declining. Gas pools discovered from 1996 to 2001 ranged from 4 to 11 BCF in the Plains-Fort St. John region, from 4 to 18 BCF in the Fort Nelson region and from 19 to 28 BCF in the Foothills.

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	Input ($/mcf)*								Output ($/mcf)		
Region	Bonus/ rental Cost	Geo. Explor.	Drilling Cost	Operating/ gathering cost	Processing cost	Provincial Royalties & Tax	Federal Tax	Input/ Pool ($million/ pool)	Gas Rev.	Liquids Rev.	Net Rev.
Plains-FSJ	0.04-0.37**	0.01-0.16	0.37-0.92	0.25-1.03	0.18-0.60	0.91-1.06	0.34-0.52	15-35	3.58-3.85	0.09-0.51	0.45-0.78
Deep Basin	0.13	0.08	1.55	0.43	0.22	0.88	0.29	32	3.74	0.03	0.24
Fort Nelson	0.11-0.23	0.04-0.14	0.61-0.87	0.46-0.54	0.40-0.64	0.90-0.94	0.26-0.38	13-57	3.59-3.68	0.01-0.09	0.33-0.52
Foothills (N)	0.10	0.06	1.12	0.67	0.44	0.92	0.28	68	3.71	0.12	0.25
Foothills (S)	0.10	0.13	0.72	0.50	1.24	0.69	0.19	100	3.76	-	0.18

* Costs are to plant exit only. Transmission tolls are not listed.

**Costs for south FSJ were exceptionally high. Bonus/rental costs in most areas within the Plains-FSJ region were around $0.20/mcf.

11.0 REGIONAL COST VARIATIONS

11.1 Regions

British Columbia has resource regions located throughout much of the Province. Northeast B.C. has been the primary focus of oil and gas exploration and development for over 50 years. There are three main regions in the northeast – Plains-Fort St. John, Fort Nelson, Foothills (trending northwest from Pine River to the Muskwa-Kechika). These are associated with the Western Canada Sedimentary Basin (WCSB). Other basins in the Province are considered immature basins. The figure "British Columbia's Energy Resources," which can be found on the Ministry of Energy and Mines website at http://www.em.gov.bc.ca/dl/Oilgas/FuelingFuture/OGCBMmap_panel.jpg, shows the locations of the Western Canada Sedimentary Basin and immature basins.

11.2 Regional Data

Regional differences have been addressed in each building block if costs and other data were available. Where appropriate, the Deep Basin has been separated from the remainder of the Plains-Fort St. John region because of significant differences in pool depths and costs to develop these. In some tables, the Foothills region has been divided into north and south areas. Wells in the south are deeper, highly sour and more costly to develop than wells in the north. Data for immature basins is either very limited or non-existent, due to the complete lack of industry and system infrastructure in some of these basins. In particular, the costs to explore and develop oil and gas resources in the Whitehorse Trough and the Bowser Basin may be double those encountered in the South Foothills. Costs could also be high in basins in the south part of the Province, such as the Georgia Basin, where planning requirements and review periods are extensive.

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11.3 Pre-tenure Planning

Pre-tenure plans are being developed by the Ministry of Sustainable Resource Management for the Muskwa-Kechika Management Area in the North Foothills region. These plans must be in place before tenures can be made available in special management zones within the management area. Plans identify sensitive resource values and objectives and strategies to support environmentally responsible development. Resource values include recreational, mineral and geothermal values, as well as environmental values.

The Foothills region has high wilderness and wildlife values but due to the relatively harsh climate conditions in the region, is more sensitive to oil and gas development than the Plains-Fort St. John and Fort Nelson regions. The same is true for many of the immature basins, which are also in mountainous areas.

11.4 Evolution of Immature Basins to Mature Producing Regions

Immature basins are areas of the province in which government or industry geologists have identified the potential oil or gas resources but there is limited drilling, minimal production and very little pipeline infrastructure. The area is first explored by geophysical operations that determine subsurface structure by recording the reflection of sound waves. If the geophysical review of seismic data indicates a structure that could trap oil or natural gas, wells will be proposed to test the subsurface interpretation. Initial wells have a high degree of failure; only one well in ten to twenty wells may be productive.

Once a number of wells are deemed to be productive, the first pipeline infrastructure is built. This infrastructure is an important step in the maturation of a basin. The first successful wells prompt additional wells; the first pipelines promote new geological investigations of potential fields in proximity to the pipelines. The presence of pipelines improves exploration economics and promotes additional geophysical exploration and drilling. This leads to production success, which in turn reduces the operating costs of the infrastructure. The reduction in transportation fees promotes a higher level of exploration, resulting in a more mature basin. As geology is better understood, infill wells (wells located between existing wells) are drilled to recover additional reserves and accelerate production.

The life of a typical pool can vary in any region, from as few as five years, if water inflow problems occur, to over 30 years. To fully deplete gas pools and maintain production as the reservoir pressure declines, wells may be worked over (stimulated) and compression can be added. Oil wells can also be worked over to optimize production rates. The recovery of oil reserves can be enhanced by injecting water or carbon dioxide to maintain the reservoir pressure as oil is produced.

In the passage of 20 to 60+ years, the basin reserves are produced and depleted.

Immature basin development is influenced by a variety of factors including the:

- location of overlying parks
- ease of access into the areas
- proximity to existing infrastructure

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- availability of corridors for infrastructure (e.g., pipelines)
- North American demand for gas supplies

Opportunities and challenges companies may face when exploring and developing immature basins, and currently undeveloped fields in the WCSB, are listed below.

11.5 Opportunities

- Significant untapped potential in Foothills, immature basins
- Strong demand – electric generation in the U.S., industrial and residential markets
- Transmission pipeline capacity
- Advances in technology for 3D(4D) seismic, drilling techniques etc.

11.6 Challenges

- Need to replace production as fields in Plains-Fort St. John, Fort Nelson mature
- Lengthy approval process in the Foothills (and immature basins)
- Land use restrictions prevent multiple underlying zones from being developed
- Volatile commodity prices
- Rising exploration and development costs
- Smaller pools, high decline rates
- Need to drill deeper plays in undeveloped areas with a shorter drilling season
- Higher hydrogen sulphide concentrations in deeper plays in Foothills
- Gas plant constraints for sour gas
- Competition from other jurisdictions
- Kyoto Accord

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